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Correspondence

Treadmills and Ergometers

Sir,

I read with interest the recent paper by Cameron *et al.*[1] comparing the Stresst'er ergometer with conventional treadmills for patients with leg pain on exercise. The comparison of two techniques is rarely straightforward, and difficulties are compounded when the established "gold-standard" technique is known to have shortcomings. In this case it is hard to know how much agreement is a good thing. Close agreement might provide reassurance that the new test is no worse than the old, whereas significant disagreement could indicate that the new test is substantially better.

It is certainly useful that Cameron *et al.* expose the weaknesses of treadmill exercise tests. However, in comparing two exercise techniques (treadmill and pedal ergometer) there are some methodological errors. The comparison "metres walked on the treadmill" vs "number of pumps", produced a correlation coefficient of 0.692 ($p<0.001$ Spearman's rank test). Although the treadmill parameters are quoted, it is not explicitly stated that the cutoff treadmill distance was 330 metres, i.e. that the treadmill would be stopped at that stage even if the patient were able to continue. Points on the graph at this distance are not strictly valid as numerical measurements, and will tend to boost the correlation coefficient artificially, which is sensitive to data points at the ends of the measurement range. Similar arguments could apply to the number of pumps, although here the upper limit is soft, in that it was imposed as a time limit of 2 min on a metronome rate of 60 beats per minute, and would therefore depend on how well the patient kept in time. The overriding impression from the graph is that the number of pumps gives almost no indication of the distance the patient will be able to walk on the treadmill. Having gone into some detail in specifying accepted values for post-exercise ankle and brachial pressure index (ABPI), it is a little frustrating that the comparison data for the two forms of exercise are entirely in the form of percentage changes pre- and post-exercise. Furthermore, in their comparison of two methods for the same measurement, it would have been much more appropriate to provide direct measures of *agreement*, rather than simply of association, by plotting the discrepancies between the two measures, and calculating the mean, standard deviation, and expected agreement limits, as described by Altman.[2]

Next the receiver-operating curve. Although the quoted are under the curve sounds impressive at 94%, it needs to be said that choosing an ABPI of 0.9 appears to yield a "true positive rate" of about 85%, and a "false positive rate" of around 10%. In the case of the treadmill the authors that the delay between exercise and pressure measurement gives time for the pulse to recover. In that case one might expect the true positive rate to be higher. From the graphical data presented there is evidence that the ergometer exercise regime induced smaller pressure changes than the treadmill. Should the ergometer exercise have been more strenuous? Probably not given the number of patients who clearly stopped short of the maximum because of "pain or other symptoms". We might then conclude that pain and vascular changes are related somewhat differently for the two forms of exercise

Finally, data on the repeatability of ABPI measurements with each exercise would be easy to acquire, and would provide an additional valid and useful basis on which to compare the two techniques.

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References

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2 Altman DG *Practical Statistics for Medical Research* London Chapman and Hall, 1991 396–403

Sir,

Having recently obtained a Stresst'er ergometer, we were very interested to read details of a two centre comparison of Stresst'er and treadmill testing in patients with claudication.[1] A number of valid points concerning the disadvantages and limitations of the traditional treadmill test were raised, many of which are commonly

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experienced in our clinic. We were encouraged to see that in this comprehensive study, all the patients were able to use the Stresst'er device, and that similar symptoms were produced with the two methods of exercising. There are, however, a number of issues which we would like to raise concerning the test protocols used and the analysis of the measurements made.

In this study, each limb was exercised on the Stresst'er by depressing the pedal at a rate of 60 per min for a maximum of 2 min. However, the treadmill exercise was for a maximum of 5 min. We would be interested to learn of the justification for this protocol design. Was the work done during each form of exercise comparable in some way? The number of metres walked on the treadmill was compared to the number of Stresst'er compressions on the worse affected leg. Significant scatter is seen around the best fit line plotted, and a cluster of points in the top right corner of the plot are of particular interest. These patients appear to have completed a full treadmill test, but were unable to complete the Stresst'er exercise. Why did these obviously fit patients fail to complete the Stresst'er exercise?

The scatter plot compared the percentage in ankle systolic pressure after exercise on the treadmill and the Stresst'er. There is significant scatter around the best fit line, with both positive and negative changes in ankle systolic pressure recorded after exercise. One would not expect the ankle pressures to increase after exercise unless the systemic blood pressure has also increased. In a similar study, mean ankle pressures were significantly lower after exercise, less than 50% of the resting pressure, and took up to 5 min to return to the resting level.[2] By comparing ankle systolic pressures alone, changes in the systemic circulation caused by the two forms of exercise are not considered. As the Stresst'er and the treadmill provide very different forms of exercise, the treamill having much more cardiovascular involvement, the changes in systemic blood pressure may be very significant. It would be more valid to compare percentage changes in the ankle–brachial pressure index (ABPI) after each form of exercise, as recommended by other authors.[3] Why have percentage changes in ankle systolic pressure been used rather than ABPI changes in this study? It was interesting to see the receiver–operator curve (ROC) for the Stresst'er. We assume that the treadmill data was used as the "gold standard" for calculating the true positive and false positive ratios although this is not clearly stated. The use of the four ABPI cut-off points, 1.0, 0.8, 0.6 and 0.4, to plot the ROC curves also caused some confusion. Wouldn't an ABPI of less than 0.6 or 0.4 suggest significant arterial disease which ever form of exercise was used to generate it? It would have been very useful if the data used to generate the ROC curve (Table 1 referenced in the legend to Fig. 4[1]), had been included.

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2 Laing SP, Greenhalgh RM Standard exercise test to assess peripheral arterial disease *Br Med J* 1980, **280** 13–16
3 Baker JD, DeEtte Dix PAC Variability of Doppler ankle pressures with arterial occlusive disease an evaluation of ankle index and brachial ankle pressure gradient *Surgery* 1980, **89** 134–137

The Stresst'er ergometer

Sir,

We read with interest the article of Cameron *et al.*,[1] but have several unanswered questions.

Firstly, what level of exercise could non-vascular patients with no motor diseases be expected to achieve with the Stresst'er to identify the "normal range"?

Secondly, from Fig. 2 it would appear that 16 patients walked less than 50 m but their number of pumps range from 10 to 110 with a mean of 50, but with a doubling of walking distance to 100 m the number of pumps increased only slightly to a range of 10–130, with a mean of 68. From this it is difficult to determine what level of pump function is related to a given walking distance which, although crude, does give one a feel for the degree of functional restriction the patient has and plan treatment appropriately.

Thirdly, the Stresst'er looks at the limb but not the whole patient. A total of 8.5% of the study patients had exercise limitation from angina or breathlessness on treadmill, indicating that their cardiorespiratory system needs optimisation prior to any consideration of vascular intervention. Would the Stresst'er be capable of identifying those with non-arterial cause of exercise limitation?

Lastly, can those with lower limb osteoarthritis, neuropathy and decreased muscle bulk satisfactorily use this system?

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